

APPENDIX K – XCEL ENERGY RESOURCES: NUCLEAR**I. NUCLEAR**

Carbon-free nuclear generation has been a cornerstone of our generation fleet for nearly fifty years, and its continued role on our system is critical to ensuring that we continue to make progress in reducing our carbon emissions. Our Preferred Plan therefore includes the extension of operations at the Monticello nuclear plant until 2040, along with the continued operation of Prairie Island through its current operating licenses (which expire outside the planning period in 2033 and 2034). By continuing the operation of these plants and extending our Monticello license, we can continue to drive the substantial carbon-free benefits that our nuclear fleet provides while saving our customers money by leveraging existing assets on our system that are leading the industry in terms of performance.

In this section, we discuss the importance of our nuclear generation fleet to our environmental and resource planning objectives. We also provide an update on the strong performance of our nuclear fleet since our 2015 Resource Plan, as well as our capital and O&M forecasts, and we discuss the results of our Strategist modeling in connection with our nuclear strategy. Finally, we discuss the economic, community, and employment benefits associated with relicensing Monticello, and we outline the regulatory processes associated with relicensing at the NRC and seeking authorization from this Commission to obtain additional dry fuel storage capacity to support extended operations.

A. Nuclear's Role in Reducing Carbon Emissions

Xcel Energy has been on the path toward significant carbon reduction for more than a decade and, since 2005, we have reduced carbon emissions 38 percent company-wide. In order to achieve our goal of an 80 percent reduction of carbon emissions by 2030, we need to retire our coal-fired generation before 2030, replace those assets with low- or no-carbon resources, and preserve the carbon-free generation that is already part of our system. Our Monticello and Prairie Island nuclear plants—which total 1,688 MWs in baseload capacity—comprise more than half of our existing carbon-free generation and one-third of our total generation. Our reliance on these

plants avoids the emission of 7 million tons of carbon dioxide each year, which is equivalent to removing 1.5 million cars from the road (or more than 20 percent of all registered vehicles in Minnesota as of 2016).

The Company simply cannot achieve similar levels of carbon reduction without nuclear generation on our system. As discussed in our Baseload Study, we will need a significant amount of firm dispatchable generation on our system in order to ensure around-the-clock reliability as we move toward a portfolio that is predominantly renewable and intermittent. We therefore believe any near- or medium-term replacement of our nuclear resources would require some amount of incremental natural gas generation, which would negatively impact our progress on reducing carbon emissions. Moreover, given MISO's current transmission expansion issues, it is far from certain that we could get sufficient renewable projects through the MISO queue in time to replace our nuclear resources. And even if that were possible, it would require substantial renewable additions beyond those already contemplated in our plan, along with supporting transmission infrastructure. Replacing the carbon free energy from Monticello with renewable resources would require over 1,000 MW of wind or nearly 3,000 MW of solar resources along with \$400 million in additional transmission investment based on our Resource Plan assumptions. Additionally, these energy only replacement estimates do not account for additional capacity costs that may be required to firm the renewable replacement or local reliability costs that would be required in the event of a Monticello retirement. The costs of adding these resources would have a significant impact on the overall cost of our Preferred Plan and would very likely jeopardize our ability to achieve the carbon reductions we envision.

We recognize that technological developments like energy storage hold great promise and that reliable, renewable baseload energy may be on the horizon. Like others, we are excited by storage technology and its potential to further transform our system, and we are taking steps as part of this Resource Plan to ensure that we are prepared to take full advantage of better technology in the future. But these technologies are still developing and, while approaching economic on a smaller scale, are not yet economic at a scale amounting to even a fraction of our nuclear fleet. For this reason, we view nuclear as a resource that will facilitate our transition to even greater renewable

generation and storage opportunities in the longer term, while we continue to pursue aggressive carbon reduction in the near-term.

Meanwhile, our nuclear fleet adds important diversity to our generation portfolio and provides a hedge against not only gas price volatility but also the uncertainty of technological development, future renewable pricing, and the future of solar capacity values. It is also a critical piece of our reliability requirement, as it is not a fuel limited resource, is not subject to pipeline limitations during the winter season, and has a strong operating history during cold (and hot) weather events. Indeed, our nuclear fleet operated at 100 percent capacity factor from January through April of 2018 and again in early 2019 during the Polar Vortex, before Monticello began to coast down in advance of its April refueling outage. Similarly, the summer months of 2018 and thus far of 2019 saw the nuclear fleet operating at full power during peak summer loads.

B. Flexible Operations Pilot

In addition to providing the carbon-free baseload energy we have relied upon for nearly 50 years, we also believe our nuclear units can be operated more flexibly in the future to complement a generation portfolio that will be predominantly renewable. In fact, we are currently piloting an operational strategy to reduce the power output of our nuclear plants when wind and solar resources are generating significant energy.¹ Historically, natural gas plants and, more recently, coal units have been “ramped” up and down to balance energy demands with the amount of renewable energy available on the system at a given time. For decades, nuclear plants have been considered “must-run” baseload power in the context of the MISO regional power market, and we therefore have focused on running at maximum power around the clock. Today, given the increasing additions of renewable resources on our system, we believe our nuclear plants can provide additional value if they can be ramped down during periods of high congestion and low prices. By doing so, the Company can take full advantage of the renewable resources on its system—both now and in the future—and can deliver even greater value from our carbon-free nuclear plants.

¹ We are also part of an industry working group on Flexible Power Operations at EPRI to gain insight from around the industry on this issue.

In 2018, the Company launched an initiative to demonstrate our nuclear fleet's ability to enter MISO's "Day Ahead" market and successfully maneuver one unit at Prairie Island between 75 percent and 100 percent power. Working with MISO, Prairie Island Unit 2 maneuvered through a series of power adjustment and simulated its participation in the Day-Ahead market, and we have since demonstrated similar operational flexibility at Prairie Island Unit 1 and Monticello. In fact, Prairie Island Unit 1 is already participating in the MISO Day Ahead market, and we expect Monticello to join that market in September and Prairie Island Unit 2 to join it in the fall after its refueling outage. In total, this means we will be able to ramp our nuclear fleet by approximately 400 MW, which will add significant operational flexibility to our overall fleet.

We believe the timing of this transition in our nuclear operations is aligned with the Company's plans to incorporate significant wind additions over the next two years, as we complete the build-out of our 1,550 MW Wind Portfolio and our Dakota Range facility. Nuclear has proven its value as the foundation of our baseload fleet, and its carbon-free generation make it a critical part of our plan to achieve an 80 percent reduction in carbon emissions by 2030. We view flexible power operations as an expansion of nuclear's role in our fleet and in the Company's efforts to integrate substantial amounts of renewable additions during the planning period.²

C. Performance & Costs

More than ever, we understand that the future of our nuclear fleet depends on our ability to deliver performance at a reasonable cost. Since our 2015 Resource Plan, we have undertaken substantial efforts to adopt wide-scale changes in the way we approach plant operations—with the goal of "bending the cost curve". And with the assistance of third-party consultants with expertise in both nuclear operations and general cost containment and efficiency strategies, as well as our continued work with the Institute of Nuclear Power Operations (INPO) and Nuclear Energy Institute (NEI), we have achieved industry-leading results not only in the performance of our

² We are also in the early stages of exploring the possibility of using nuclear energy to produce hydrogen, which in turn could be used both in the transportation sector and as energy storage. Xcel Energy has partnered with two other utilities to explore the economics and overall feasibility of nuclear-driven hydrogen production, and an \$8 million funding request is currently pending with the Department of Energy's Light Water Reactor Sustainability Group.

nuclear plants but also in the costs we are investing to achieve that performance. In short, our nuclear plants have never operated on a more consistent, efficient, and safe basis.

1. *Safety*

Beginning with safety, the NRC Reactor Oversight Process classifies U.S. nuclear reactors into various “Columns,” which range from 1 (best) to 5 (worst). Both Monticello and Prairie Island are Column 1 plants with all green performance indicators. And while no plant can achieve the standards of perfection imposed by the NRC at all times over its operational life, we believe our track record demonstrates the Company’s longstanding commitment to nuclear safety. Further, during the 2R30 refueling outage in 2017, Prairie Island achieved its best industrial safety record (no OSHA or First Aid injuries) and the lowest occupational radiation exposure in plant history, and both plants have received the Governor’s annual safety award for several years running.

2. *Capacity Factor*

With respect to plant availability, Monticello achieved an average capacity factor of 96.5 percent over the past three years, including a record-setting 99.3 percent in 2018. Likewise, Prairie Island achieved a combined average capacity factor of more than 90 percent over the past three years, including a 100 percent capacity factor for Unit 2 in 2018. This data reflects strong and improved performance at both plants, and the increased availability of our plants drives substantial customer benefits given the fixed costs associated with nuclear fuel. Contributing to these capacity factors was improved performance during plant refueling outages, which were completed on time and on budget. For example, in 2017, Prairie Island’s Unit 2 achieved a 37-day refueling outage, which is that unit’s shortest refueling duration in 10 years. Likewise, we have experienced some of the longest runs of uninterrupted operation in the history of our nuclear fleet, including a record-setting 499 days at Prairie Island Unit 1 in 2016-2017, and a current run of 583 days (as of June 27, 2019) at Prairie Island Unit 2. In fact, Prairie Island Unit 2 is currently on the third longest run in plant history.

3. *O&M and Production Costs*

Importantly, we have achieved these safety and operational results without increasing our production costs. In fact, both O&M and total production costs at our plants have decreased significantly in recent years. Total O&M for our nuclear fleet went down by \$7 million between 2015 and 2016. It then decreased again by another \$26 million in 2017, and decreased yet again in 2018 by another \$8 million.

In terms of production costs (fuel plus O&M) per MWh, we achieved reductions of more than 20 percent between 2015 and 2018.³ Specifically, our fleet average nuclear production costs have gone from \$37.86 per MWh in 2015 down to \$29.44 in 2018 (Prairie Island has gone from \$37.08 down to \$28.53, and Monticello has gone from \$39.11 down to \$30.91).

Contributing to these results has been Xcel Energy's commitment to driving efficiency through its XE1 initiative, which focused on process development and refinement and the integration of technology to achieve efficiencies. Industry experience shows that successful nuclear organizations are highly process and outcome driven and that focused process improvement has the benefit of driving down costs while at the same time improving plant performance. Through our work with the external consultants and INPO, we have been able to effectively improve upon a number of processes and personnel behaviors that has enabled the plant to achieve better results with fewer resources.

4. *Capital*

We have also completed a long-term re-analysis of our capital budgets for both Prairie Island and Monticello, and we have made significant changes to our capital forecast relative to our 2015 resource plan. In our 2015 resource plan, we stated that our projected capital spend for Prairie Island was outpacing the estimates included in our 2012 Changed Circumstances filing. We specifically noted that our five-year capital expenditure forecast from 2016 through 2020 had increased by roughly \$175 million above what was anticipated in 2012, and that our forecast for the 13-year period from 2021 through 2034 would likely need to increase by roughly \$600 to \$900 million. At

³ These reductions in our nuclear production costs are directionally consistent with the nuclear industry as a whole, which has achieved a more modest average reduction of approximately \$5/MWh since 2012.

the same time, we noted that our O&M costs were lower than previously modeled and that those decreases in O&M offset the increases in forecasted capital spend.

Today, we are in a position to materially reduce our capital forecasts. To date, we have spent \$77 million less at Prairie Island than we anticipated in 2015. And relative to that 2015 Resource Plan budget, we now forecast spending approximately \$475 million less in capital at our nuclear plants from 2019 through their current licenses relative to our 2015 forecast (approximately \$245 million less at Prairie Island and about \$230 million less at Monticello during this period, excluding incremental spend required for the ten-year extension).

The updates to our forecast reflect several years of work by numerous Company employees, leadership, and external consultants, as well as a recognition that we had to re-envision our approach to nuclear operations if our plants were going to remain competitive. The forecasts are based on a detailed, long-range capital budgeting process that was undertaken following our last Resource Plan. As part of this process, teams from nuclear engineering and capital projects assessed the condition of our plants and developed a long-range project forecast to support continued operations and aging management. These teams then worked with nuclear finance to develop budgets to support project needs, and probabilities were assigned to the various projects reflecting the likelihood each would be necessary to maintain the reliability of our plants. We then worked with independent consultants with expertise in nuclear operations to assess both our budgeting process and the overall level of our capital budgets, in order to ensure that our forecast were reasonable and aligned with industry norms.

We recognize that our stakeholders and the Commission will continue to monitor our performance and investments relative to our forecasts, and we anticipate an in-depth discussion regarding our Monticello forecasts in the context of a future certificate of need filing for additional dry cask storage. We anticipate filing that petition in the mid-2020s, at which point we will have an even longer track record of performance both in terms of capacity factors and spend. We look forward to demonstrating that our nuclear plants can continue to drive both environmental performance and benefits for our customers.

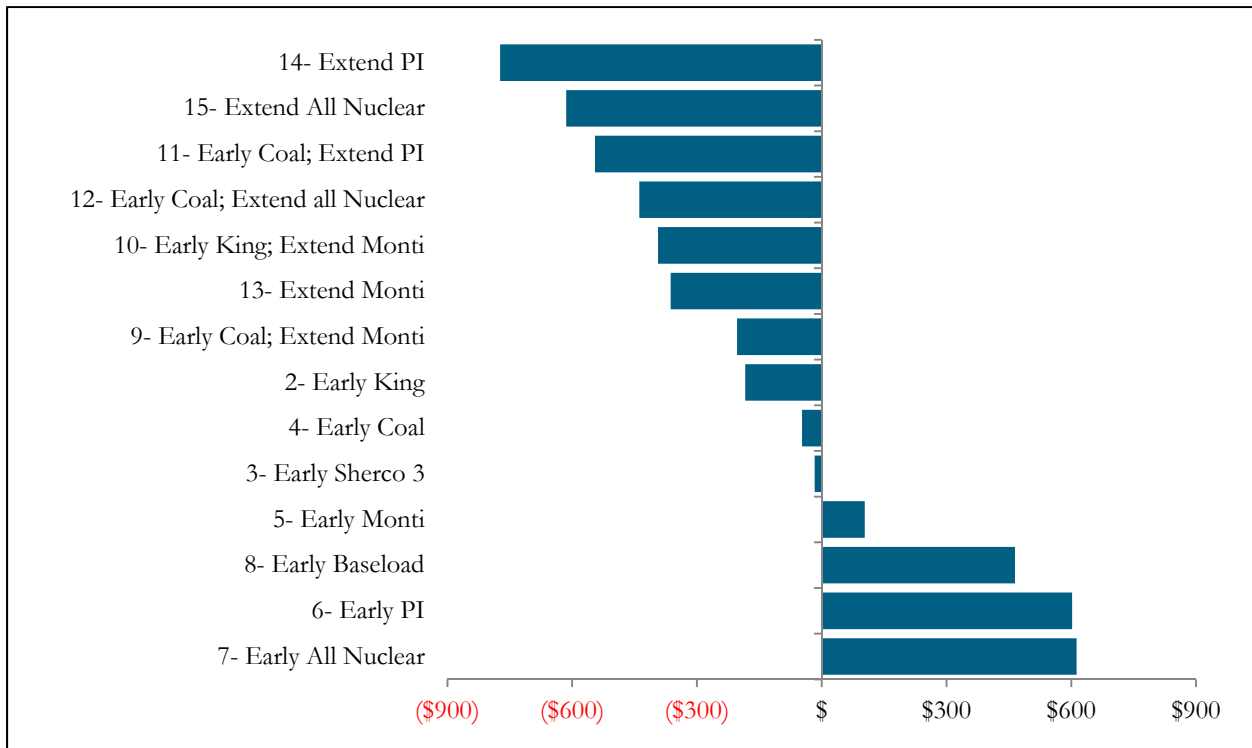
D. Benefits of Relicensing

Our Preferred Plan includes the operation of Prairie Island through its current licenses (expiring in 2033 and 2034) and a ten-year extension on the operation of Monticello (through 2040). The Strategist modeling of our plan demonstrates both that the continued operation of Prairie Island and the extension of Monticello are cost effective and expected to result in customer benefits. We discussed our Economic Modeling Framework in Chapter 5 but we briefly summarize the nuclear-specific results below.

As part of our economic analysis, we modeled scenarios that included early retirements, license extensions, and continued operation through current licenses for all three of our nuclear units. For the early retirement scenarios, we assumed a 2026 retirement date for Monticello and 2025-2026 retirement dates for Prairie Island Units 1 and 2, respectively. For license extensions, we limited our analysis to ten additional years of operations. While the NRC grants license extensions in 20-year increments, we believe it is prudent to limit our analysis to 10 additional years at this juncture, given the uncertainty of projecting more than 30 years into the future from both a budgeting and resource-planning perspective. Thus, the license extension dates are 2040 for Monticello, 2043 for Prairie Island Unit 1, and 2044 for Prairie Island Unit 2. We then combined these various scenarios with consideration of early coal retirements in order to develop a Preferred Plan.

In general, our analysis shows that extending operation of our nuclear plants is beneficial and least-cost when compared to other scenarios. The following table summarizes the Strategist results for each of the modeled scenarios:

**Figure 1: Scenario PVRR Deltas from Reference Case
 (\$2019 millions)**



To be clear, our Preferred Plan is not the least cost scenario of the 15 options considered in terms of either PVSC or PVRR savings. The least-cost scenarios all include an extension of Prairie Island in addition to Monticello. But we believe the later retirement dates for Prairie Island—which are outside the planning period of the Resource Plan—give us additional time to consider this option before pursuing a license extension at Prairie Island.

Nevertheless, our Strategist modeling demonstrates that the extension of Monticello for an additional ten years is least cost and in our customers’ interest. It also demonstrates that the continued operation of Prairie Island is superior to any of the early retirement scenarios. We believe these results provide strong support for our Preferred Plan and demonstrate the importance of our nuclear fleet from an overall resource planning perspective.

In addition to the economic benefits identified by Strategist, we believe it is also important to note the state, community, and employment benefits associated with our

nuclear fleet. Our plants employ approximately 1,400 staff in and around the Monticello and Red Wing communities, which translates into an estimated 4,200 additional jobs in other industries across Minnesota. The plants are also an important source of tax base for their host communities, resulting in a combined total of approximately \$42 million in state and local taxes annually. In total, Xcel Energy's nuclear operations contribute approximately \$1 billion in annual economic benefits throughout the state. These and other benefits are summarized in NEI's April 2017 report titled "The Impact of Xcel Energy's Fleet on the Minnesota Economy," which looked at data from 2014-2016⁴ and is included as Appendix O3.

In short, we believe our nuclear plants provide wide-ranging and substantial benefits not only to our customers but also the environment, the State of Minnesota, and the communities we serve. The continued operation of these plants, including a ten-year extension of operations at Monticello, is in the public interest, is consistent with state policy, and is necessary to achieve our carbon reduction goals at a reasonable cost.

E. Relicensing & Certificate of Need

Although 2030 is more than a decade away, the NRC relicensing process is a long-term project that must be commenced during the five-year action plan of this Resource Plan. In this section, we discuss the NRC process of relicensing Monticello for an additional 20 years, as well as the Certificate of Need filing we will make for additional dry fuel storage.

The Atomic Energy Act authorizes the NRC to issue licenses for commercial power reactors to operate for up to 40 years.⁵ These licenses can then be renewed for additional 20-year periods of "extended operation" under the NRC's License renewal rule (10CFR Part 54). Both Monticello and Prairie Island successfully received NRC approval for initial license extensions and are currently operating under the extended licenses. Approximately 90 percent of plants in the United States have already

⁴ The 1,400 staff and \$42 million in state and local taxes referenced above reflects updated information as through 2018.

⁵ Economic and antitrust considerations, not limitations on nuclear technology, determined the original 40-year term for reactor licenses. However, because of this selected time period, some systems, structures, and components may have been engineered on the basis of an expected 40-year service life. As such, a renewed license requires "aging management programs," to monitor and manage the effects of continued operation on these equipment and structures.

renewed their licenses once, extending their operation to 60 years. Most of these plants will soon reach the end of their 60-year term, and many are in the process of considering a subsequent license renewal (SLR), which would extend a plant's operation from 60 to 80 years.

To obtain an SLR, a plant must provide the NRC with an assessment of the technical aspects around plant ageing and demonstrate that it can continue to operate safely.⁶ This includes review of system metals, welds and piping, concrete, electrical cables, and reactor pressure vessels. The renewal process also includes an evaluation of potential environmental impacts associated with an additional 20 years of operation. The NRC verifies evaluations through inspections and audits, and its review of license renewals is expected to last anywhere between 22 and 30 months.

That said, there is no requirement that the NRC complete its review within this time frame. There is, however, a five-year safe-harbor provision that allows operators to ensure that a plant's license will not expire during the NRC review process.⁷ Specifically, 10CFR2.109(b) provides that the existing license for a plant will not be deemed to have expired during the SLR review process, provided that the licensee filed its application at least five years before the expiration of the current license. Additionally, we note that the NRC is currently reviewing three plants that have already submitted SLRs as part of a pilot program that is intended to pave the way for efficient processing of relicensing applications in the 2020s. We expect that the three pilot plants will receive license extensions in early 2020.

We intend to comply with the five-year safe-harbor in order to ensure that Monticello can continue operating throughout the entirety of the SLR review process. And because the five-year clock does not begin to run until an application is deemed "sufficient," we intend to submit our SLR application an additional six months early so that any completeness issues can be resolved before the five-year mark. Based on our experience with the first extensions for Prairie Island and Monticello, we further anticipate that it will take approximately three years to prepare the license renewal

⁶ Each reactor's original license is based on a specific set of requirements, depending primarily on design. This set of requirements is called the plant's "licensing basis." The licensing renewal process provides continued assurance that the current licensing basis will maintain an acceptable level of safety for the period of extended operations.

⁷ Once a license expires, a nuclear plant cannot return to operation, so it is important to comply with the safe harbor in order to avoid license expiration during the pendency of an SLR application.

application itself. This means we need to begin the SLR application process in mid-2021, so that we can submit the application to the NRC in mid-2024 (five-and-a-half years before the current license expiration in 2030).

We recognize that the Commission's ultimate decision as to the extension of Monticello will occur in the context of a Certificate of Need for additional dry cask storage, and we anticipate filing that petition in the mid-2020s when we are farther along in the SLR submittal preparation for the NRC review. However, because our work to prepare the SLR application will occur between 2021 and 2024, we are requesting that the Commission approve this work as part to of our proposed five-year action plan. In total, we estimate that the application renewal process will cost approximately \$40-50 million, and we have accounted for this cost in our Strategist modeling. We will justify the reasonableness and prudence of these costs in a future rate case.

Meanwhile, we will continue to lead the industry in exploring used fuel strategies, including consolidated interim storage and transportation issues that may facilitate additional used fuel management options not yet available in the industry. Just two months ago, Xcel Energy hosted an NEI nuclear transportation table top exercise that simulated shipping casks across the county to an interim storage site. This first-of-its-kind exercise involved the participation of several organizations—including the NRC, state commissions, host communities, tribal governments, and other utilities—all of whom will be important partners as we work on fuel management options. Thus, while we have the expertise and facility to safely store used fuel on site at our plants into the future, we will continue to lead the industry in exploring alternative transportation and storage opportunities.

F. Conclusion

This Resource Plan filing represents the first of many steps that will be required to obtain the necessary approvals to extend the Monticello operating license. This process will involve an extended dialogue with our stakeholders and regulators, both at the NRC and our state Commissions. We look forward to engaging with our stakeholders around the role of nuclear in our energy future.

Our specific request in this Resource Plan is to approve a five-year action plan that includes the preparation of an SLR license application, so that we can proceed on a timeline that allows for the potential relicensing of Monticello until 2040. If the Commission approves this plan, we will be back in the coming years to seek a Certificate of Need for additional dry fuel storage. At that time, we would expect to have a more in-depth discussion regarding the detailed capital and O&M forecasts, as well as the impacts of continued operations on the local communities, the state, and our customers.